

(19)

Europäisches Patentamt

European Patent Office

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(11)

EP 0 863 601 A1

(12)

## EUROPEAN PATENT APPLICATION

(43) Date of publication:

09.09.1998 Bulletin 1998/37

(51) Int. Cl.<sup>6</sup>: H02K 3/52

(21) Application number: 98103639.5

(22) Date of filing: 02.03.1998

(84) Designated Contracting States:

AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC  
NL PT SE

Designated Extension States:

AL LT LV MK RO SI

(30) Priority: 03.03.1997 JP 47527/97

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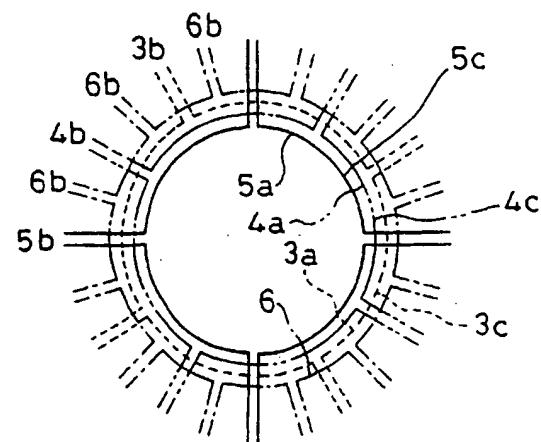
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## (54) Connection configuration for stator

(57) The present invention has an object of providing a rational connection configuration for an inner rotor type stator comprising coil windings provided for each pole blade. Accordingly, the connection configuration of the invention comprises three types of electric conductors (3a, 4a, 5a) corresponding to U-, V- and W-phases, respectively, and shaped like a ring. Each electric conductor has a projection (3b, 4b, 5b) extended in four directions corresponding to four groups of coil windings (2) each of a same phase, and a lead (3c, 4c, 5c) representing each phase and extending outward of an outer diameter of the stator. The electric conductors (3a, 4a, 5a) and a common electric conductor (6) are arranged on an end plate (7) concentrically. Connections between the coil windings (2) and the projections (3b, 4b, 5b) respectively of the same phase are radially arranged at places outward of the grooves (7b) of the end plate (7) so as to effect connection therebetween.

FIG.3



## Description

### FIELD OF THE INVENTION

The present invention relates to a connection configuration for stator for use in rotary machines and more particularly, to a connection configuration for coil windings of an inner rotor type stator.

### BACKGROUND OF THE INVENTION

Recent stators have separate coil windings for each pole blade for increasing the winding density. It is a general practice in the art to adopt a Y-configured connection for this type of stator in order to reduce circulating current occurred due to unbalance among individual coil windings.

As the Y-configured connection, there have been known a connection in which some of the coil windings have one ends thereof bundled together with regard to a same phase and the other ends thereof bundled together with those of the other coil windings regardless of difference in phase, and then are subjected to a connecting process by means of soldering, brazing or the like; a connection utilizing a printed board provided with printed wiring; a connection utilizing a multi-layered copper-bar board; and the like. The connection utilizing the multi-layered copper-bar board comprises a conductive board connected to the ends of coil windings of the same phase and a conductive board connected to the other ends of the coil windings in common regardless of difference in phase, with an insulating material interposed therebetween (see, for example, JP A 6-233483).

Unfortunately, however, the aforementioned connection through soldering or brazing the bundles of coil winding ends is performed by manual work which requires a great amount of time and effort. In view of a current capacity of a copper foil, the connection utilizing the printed board is not suitable in general for a large size stator which requires a flow of high current therethrough.

The connection utilizing the multi-layered copper-bar board is constructed such that conductive boards are laminated by way of interposing an insulating material therebetween, so that the overall dimensions tend to increase with respect to a direction in which the boards are laminated. In addition, the conductive board is formed by pressing a copper sheet, requiring a press machine and a die for each frame. Consequently, the equipment for preparing this type of connection is complicated and large on scale.

### DISCLOSURE OF THE INVENTION

In view of the foregoing, it is an object of the present invention to provide a rational connection configuration for an inner rotor type stator with coil windings provided

for each pole blade.

For achieving the above object, the invention is characterized in that electric conductors covered with an insulating material are disposed in grooves of an end plate and respectively connected to ends of coil windings of the same phase. Thus, a rational stator facilitating a connecting process is provided.

That is, a connection configuration for stator according to a first aspect of the invention pertains to a stator including a stator core formed of coil windings provided for each pole blade, and comprises coil windings provided for each pole blade and grouped into respective phases, electric conductors covered with an insulating material and worked into a bent form, and an end plate formed with grooves for fittedly receiving the aforesaid electric conductors, wherein the end plate is disposed on the coil windings and adapted to fittedly receive the electric conductors in the grooves thereof, and the electric conductors are connected to the coil windings grouped into the respective phases.

Thus, the insulated electric conductor according to the invention may be readily obtained by bending a covered wire such as a polyurethane copper wire. Since the electric conductors are fitted in the grooves formed in the end plate, positioning of the electric conductors is facilitated so that the coil windings may be readily connected to the electric conductors by means of crimping or the like.

A connection configuration for stator according to a second aspect of the invention is characterized in that the electric conductors are fixed in the grooves of the end plate.

Since the electric conductors are fixed in the respective grooves of the end plate, an operation for connecting the coil windings to the electric conductors is facilitated.

A connection configuration for stator according to a third aspect of the invention is characterized in that the electric conductor has a projection projecting outward and overlapping with an end of the coil winding for connection therebetween.

Since the connection is formed by way of overlapping the projection of the electric conductor and the end of the coil winding, the connected portion may have a greater contact area, thereby increasing stability. This leads to an easy connecting operation.

A connection configuration for stator according to a fourth aspect of the invention is characterized in that the electric conductors have leads representing the respective phases of the coil windings and extended out of an outer diameter of the stator.

Owing to the provision of the leads representing the respective phases of the coil windings and extended out of the outer diameter of the stator, direct connection with other peripheral equipments becomes possible, and a quantity of wiring material to be used and the number of steps for the connecting process can be reduced.

**Description****FIELD OF THE INVENTION**

The present invention relates to a connection configuration for stator for use in rotary machines and more particularly, to a connection configuration for coil windings of an inner rotor type stator.

**BACKGROUND OF THE INVENTION**

Recent stators have separate coil windings for each pole blade for increasing the winding density. It is a general practice in the art to adopt a Y-configured connection for this type of stator in order to reduce circulating current occurred due to unbalance among individual coil windings.

As the Y-configured connection, there have been known a connection in which some of the coil windings have one ends thereof bundled together with regard to a same phase and the other ends thereof bundled together with those of the other coil windings regardless of difference in phase, and then are subjected to a connecting process by means of soldering, brazing or the like; a connection utilizing a printed board provided with printed wiring; a connection utilizing a multi-layered copper-bar board; and the like. The connection utilizing the multi-layered copper-bar board comprises a conductive board connected to the ends of coil windings of the same phase and a conductive board connected to the other ends of the coil windings in common regardless of difference in phase, with an insulating material interposed therebetween (see, for example, JP A 6-233483).

Unfortunately, however, the aforementioned connection through soldering or brazing the bundles of coil winding ends is performed by manual work which requires a great amount of time and effort. In view of a current capacity of a copper foil, the connection utilizing the printed board is not suitable in general for a large size stator which requires a flow of high current therethrough.

The connection utilizing the multi-layered copper-bar board is constructed such that conductive boards are laminated by way of interposing an insulating material therebetween, so that the overall dimensions tend to increase with respect to a direction in which the boards are laminated. In addition, the conductive board is formed by pressing a copper sheet, requiring a press machine and a die for each frame. Consequently, the equipment for preparing this type of connection is complicated and large on scale.

**DISCLOSURE OF THE INVENTION**

In view of the foregoing, it is an object of the present invention to provide a rational connection configuration for an inner rotor type stator with coil windings provided

for each pole blade.

For achieving the above object, the invention is characterized in that electric conductors covered with an insulating material are disposed in grooves of an end plate and respectively connected to ends of coil windings of the same phase. Thus, a rational stator facilitating a connecting process is provided.

That is, a connection configuration for stator according to a first aspect of the invention pertains to a stator including a stator core formed of coil windings provided for each pole blade, and comprises coil windings provided for each pole blade and grouped into respective phases, electric conductors covered with an insulating material and worked into a bent form, and an end plate formed with grooves for fittedly receiving the aforesaid electric conductors, wherein the end plate is disposed on the coil windings and adapted to fittedly receive the electric conductors in the grooves thereof, and the electric conductors are connected to the coil windings grouped into the respective phases.

Thus, the insulated electric conductor according to the invention may be readily obtained by bending a covered wire such as a polyurethane copper wire. Since the electric conductors are fitted in the grooves formed in the end plate, positioning of the electric conductors is facilitated so that the coil windings may be readily connected to the electric conductors by means of crimping or the like.

A connection configuration for stator according to a second aspect of the invention is characterized in that the electric conductors are fixed in the grooves of the end plate.

Since the electric conductors are fixed in the respective grooves of the end plate, an operation for connecting the coil windings to the electric conductors is facilitated.

A connection configuration for stator according to a third aspect of the invention is characterized in that the electric conductor has a projection projecting outward and overlapping with an end of the coil winding for connection therewith.

Since the connection is formed by way of overlapping the projection of the electric conductor and the end of the coil winding, the connected portion may have a greater contact area, thereby increasing stability. This leads to an easy connecting operation.

A connection configuration for stator according to a fourth aspect of the invention is characterized in that the electric conductors have leads representing the respective phases of the coil windings and extended out of an outer diameter of the stator.

Owing to the provision of the leads representing the respective phases of the coil windings and extended out of the outer diameter of the stator, direct connection with other peripheral equipments becomes possible, and a quantity of wiring material to be used and the number of steps for the connecting process can be reduced.

## DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded perspective view showing a stator according one embodiment of the invention; Fig. 2 is an exploded perspective view showing electric conductors and an end plate; Fig. 3 is a diagram explaining an arrangement of electric conductors dedicated to respective phases and a common electric conductor; Fig. 4 is a sectional view showing an end plate according to another embodiment of the invention; Fig. 5 is a sectional view showing a connected portion; Fig. 6 is a perspective view showing a principal portion of the connected portion between an electric conductor and a coil winding; and Fig. 7 is a plan view showing an example of how to house the connected portion.

## DESCRIPTION OF PREFERRED EMBODIMENTS

Preferred embodiments of the invention will hereinbelow be described with reference to the accompanying drawings.

Referring to Figs. 1 and 5, indicated by 1 is a pole blade of a stator core and by 2 is a coil winding around the pole blade. In Fig. 2, reference numerals 3a, 4a and 5a each denote an electric conductor connected to the coil winding, reference numerals 3b, 4b and 5b each denote a projection provided at each electric conductor, and reference numerals 3c, 4c and 5c each denote a lead provided at each electric conductor. Indicated by 6 is a common electric conductor and by 6b is a projection provided at the common electric conductor. A reference numeral 7 denotes an end plate for housing the electric conductors and reference numerals 7a and 7b denote grooves formed in the end plate for receiving the electric conductors. In Fig. 4, a reference numeral 8 denotes an end plate according to another embodiment of the invention.

Now returning to Fig. 1, the stator has twelve separate pole blades, each being provided with the coil winding 2 therearound before fixed in place. The stator is adapted to correspond to a three-phase structure including a U-phase, a V-phase and a W-phase and arranged such that the twelve pole blades 1 are disposed circumferentially of the stator at regular intervals and provided with coil windings corresponding to the U-, V- and W-phase in this circumferential order. That is, four pole blades provided with coil windings corresponding to the same one phase of the three phases are separately arranged circumferentially at regular intervals of every three pole blades.

The four coil windings 2 of the same phase, the U-phase for example, fitted around the respective pole blades have their respective leading ends connected to the conductor 3a. Likewise, the leading ends of the coil windings of the V-phase are connected to the conductor

5 4a and the leading ends of those of the W-phase are connected to the conductor 5a. On the other hand, the opposite ends or trailing ends of the twelve coil windings are connected to one common conductor 6, thus establishing the Y-configured connection of the coil windings of the U-, V- and W-phases. More specifically, the three types of conductors 3a, 4a and 5a corresponding to the U-, V- and W-phases and the common conductor 6 are concentrically arranged on the end plate 7, having their respective connected portions radially arranged in grooves 7b of the end plate 7 for connection with the respective ends of the coil windings 2.

10 15 The three types of conductors 3a, 4a and 5a and the common conductor 6 are formed of, for example, a copper wire covered with multiple insulation layers of polyimide, polyester and the like and bent in conformity with each of the grooves 7a. Examples of a usable connection method include a calking method utilizing a calking contact, a fusing method by means of resistance welding, soldering, brazing and the like.

20 As seen in Fig. 2, the electric conductors 3a, 4a and 5a are shaped like a ring and each correspond to four coil windings 2 of the same phase. The conductors have the projection 3b, 4b and 5b, respectively, projected outward as well as the lead 3c, 4c and 5c representing the respective phases and extending outward of an outer diameter of the stator.

25 30 35 The common conductor 6 is also shaped like a ring and has twelve projections 6b projected outward of its circumference and disposed at regular intervals so as to correspond to the respective pole blades 1.

The end plate 7 is formed of an insulating material such as a synthetic resin, having a donut-like shape. The end plate includes ring-like grooves 7a concentrically arranged therein for receiving the electric conductors 3a, 4a and 5a, respectively, and radially arranged grooves 7b for leading out the projections 3b, 4b and 5b.

40 Now, description will be made on the procedure for connecting wires in the abovementioned arrangement.

First, the common electric conductor 6 is inserted in the outermost of the grooves 7a and the grooves 7b of the end plate 7, then the electric conductors 3a, 4a and 5a are inserted in the grooves 7a and 7b subsequently in the order of from the outer to the inner. The positional relationship among the projections 3b, 4b and 5b at this time is shown in Fig. 3. However, the positional relationship between the electric conductors 3a, 4a and 5a and the common electric conductor 6, and that among the leads 3c, 4c and 5c are not particularly specified.

50 55 Alternatively, as seen in Fig. 4, the electric conductors may be arranged in an end plate 8 in a manner according to another embodiment.

Subsequently, as shown in Figs. 5 and 6, the end plate 7 is fixed onto an upper portion of the coil windings of the stator. The leading ends of the coil windings 2 are overlapped with the projections 3b, 4b and 5b, while the trailing ends of the coil windings 2 are overlapped with the projections 6b. Each overlapped portion is covered

with a caulking member 9 and then caulked for establishing the connection between the coil winding and the electric conductor. Shown in Fig. 7 is an example of places for housing the connected portions. The connected portions may be housed in such a manner that the connected portions do not extend beyond the outer diameter of the stator.

If the electric conductors are inserted in the grooves of the end plate 7 or 8 and then fixed thereto by means of resin monolithic molding, welding, bonding or the like, the subsequent connecting process may be facilitated. Although the embodiment of the invention has been described by way of an example of twelve pole blades, the embodiment may also be practiced in the same manner regardless of the number of pole blades, provided that the stator comprises three-phase coil windings.

As described above, the connection configuration of the invention is arranged such that the electric conductors 3a, 4a and 5a covered with an insulating material are provided with the projections 3b, 4b and 5b for connection with the coil windings 2, and are received in the grooves 7a and 7b of the end plate 7, thus allowing a simple equipment to accomplish the connection between the electric conductors and the coil windings 2. Further, since the projections 3b, 4b and 5b of the electric conductors are overlapped with the respective ends of the coil windings for connection therebetween, the connecting process may be performed in a more stable manner.

Furthermore, in the connection configuration wherein the electric conductors representing the respective phases of the coil windings 2 have the leads 3c, 4c and 5c for leading respective one end thereof out of the outer diameter of the stator, direct connection with other apparatuses is possible. This contributes to reduction of the wiring material to be used and of the number of steps for the connecting process.

In this result, a rational connection configuration is provided for a stator of an inner-rotor type stator, particularly of a large size, in which coil windings are provided for each pole blade.

## Claims

1. A connection configuration for stator including a stator core formed of coil windings 2 provided for each pole blade 1, the configuration comprising:

coil windings 2 provided for each pole blade 1 and grouped into respective phases;

electric conductors 3a, 4a and 5a covered with an insulating material and worked into a bent form; and

an end plate 7 formed with grooves 7a and 7b for fittedly receiving the electric conductors 3a, 4a and 5a;

wherein said end plate is disposed on

the coil windings 2 and adapted to fittedly receive the electric conductors 3a, 4a and 5a in the grooves 7a and 7b thereof, and said electric conductors are connected to the coil windings grouped into the respective phases.

5 2. A connection configuration for stator as set forth in Claim 1, wherein the electric conductors 3a, 4a and 5a are fixed in the grooves 7a and 7b of the end plate.

10 3. A connection configuration for stator as set forth in Claim 2, wherein the electric conductors 3a, 4a and 5a have projections 3b, 4b and 5b projecting outward and overlapping with one end of the coil windings for connection therebetween.

15 4. A connection configuration for stator as set forth in any one of Claims 1 to 3, wherein the electric conductors 3a, 4a and 5a have leads 3c, 4c and 5c representing the respective phases of the coil windings 2 and extended out of an outer diameter of the stator.

20 5. A connection configuration for stator as set forth in Claim 1 or 2, wherein the end plate 7 is formed with a plurality of grooves 7a of concentric circular shapes for receiving the electric conductors 3a, 4a and 5a, and with radial grooves 7b overlapping with the concentric circular grooves.

25 6. A connection configuration for stator as set forth in any one of claims 1 to 4, wherein

30 35 the electric conductors 3a, 4a and 5a are each shaped like a ring so as to be received by the concentric circular grooves 7a, and in correspondence to the coil windings 2 grouped into the respective phases, have projections 3b, 4b and 5b projecting outward, as well as leads 3c, 4c and 5c representing the respective phases and projecting outward of the outer diameter of the stator, and

40 40 a common electric conductor 6 is also shaped like a ring, and in correspondence to the respective polar blades, has projections 6b extending outward of its circumference.

45 45

FIG.1

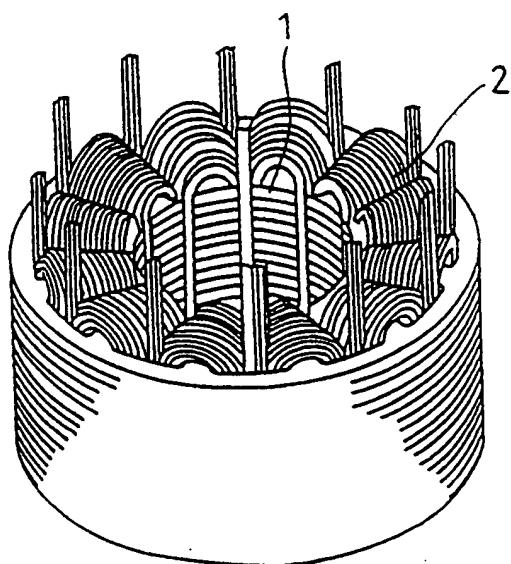
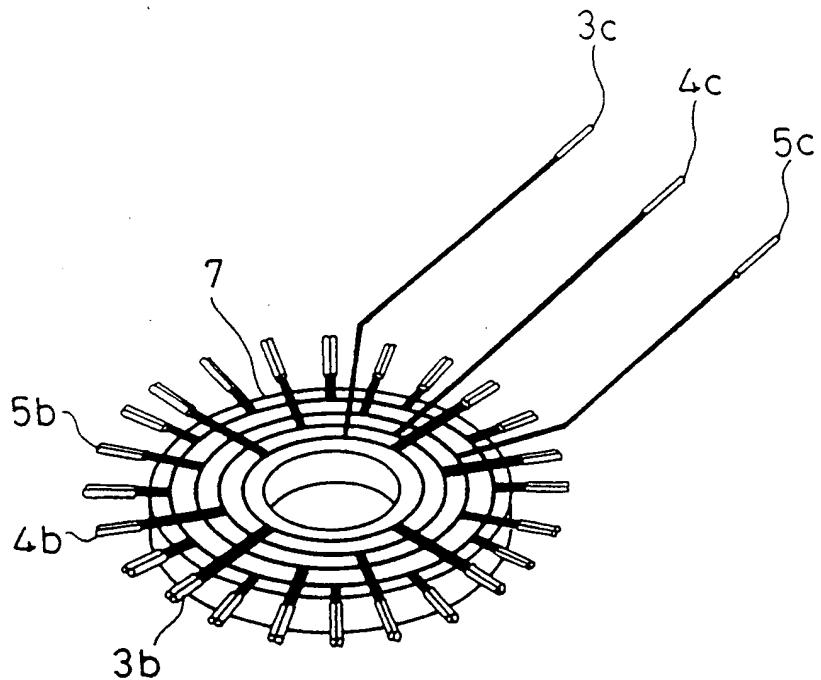


FIG.2

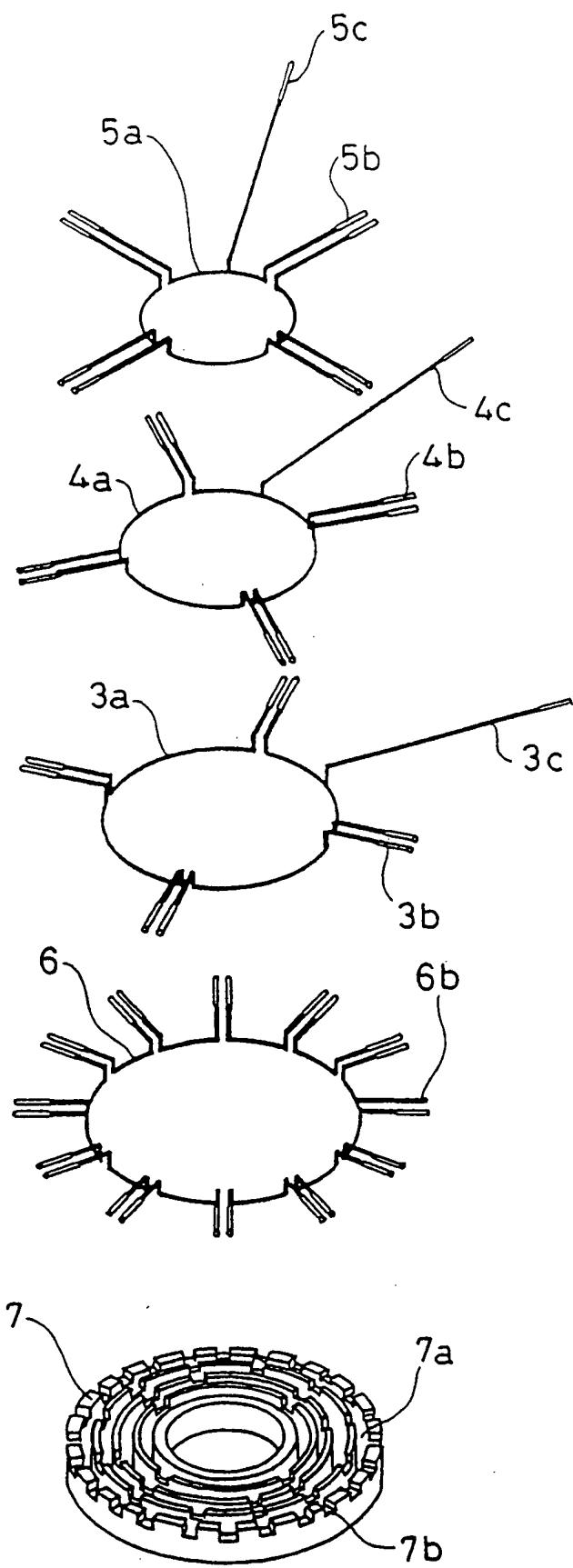


FIG.3

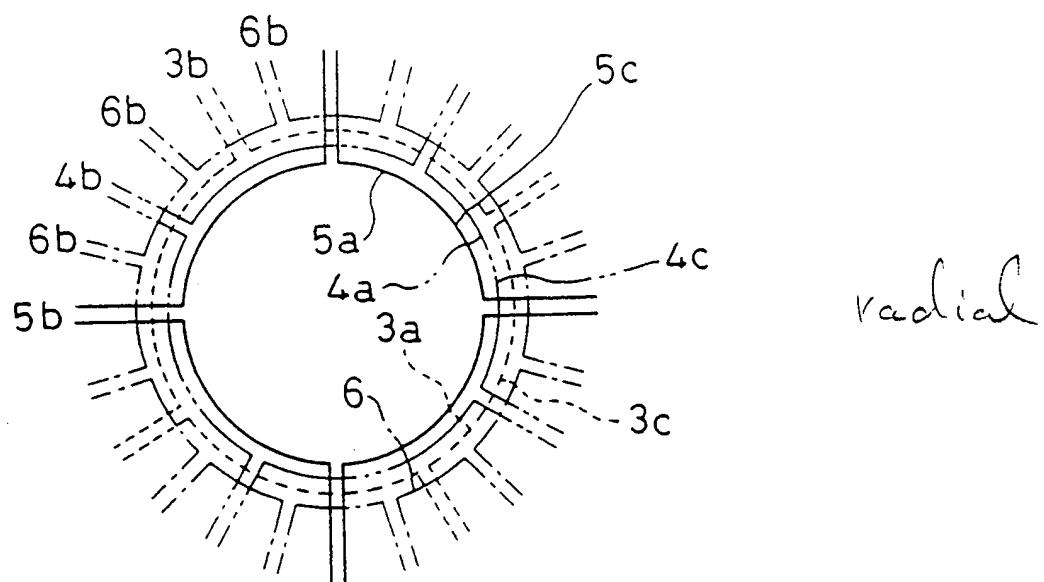


FIG.4

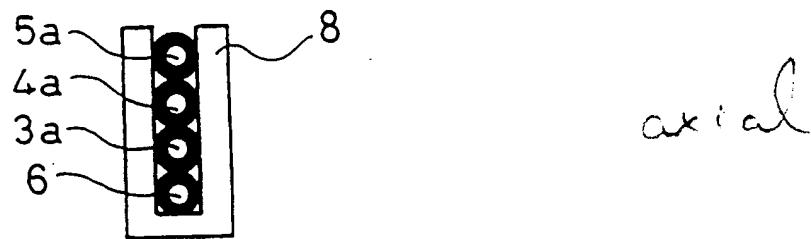


FIG.5

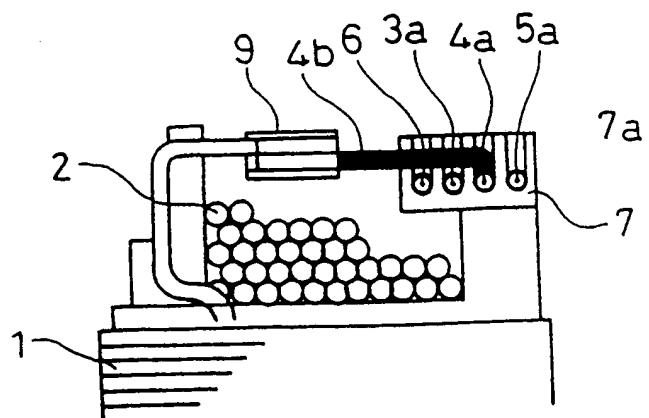


FIG.6

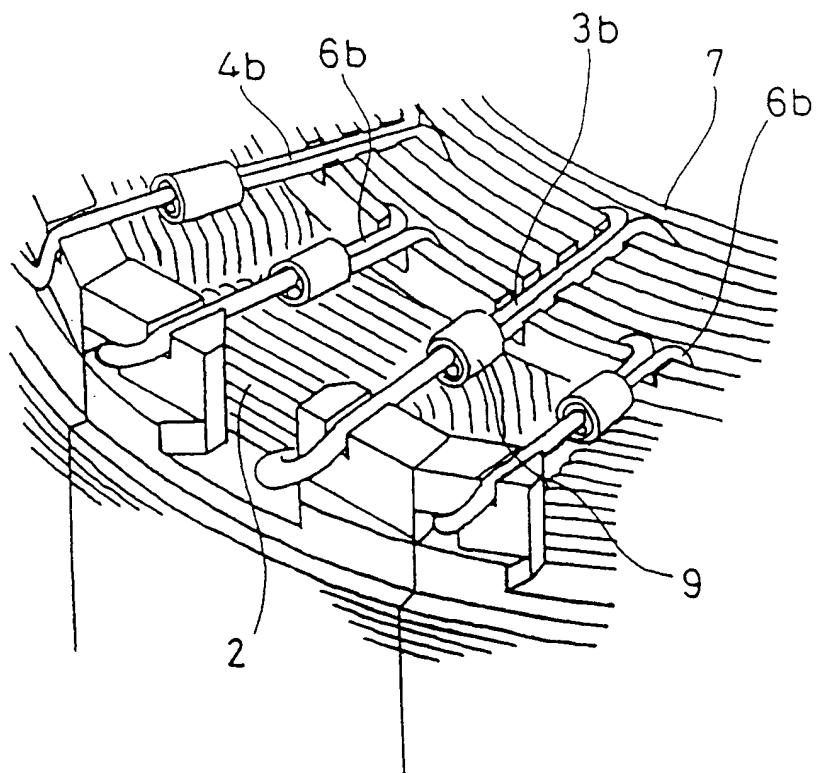
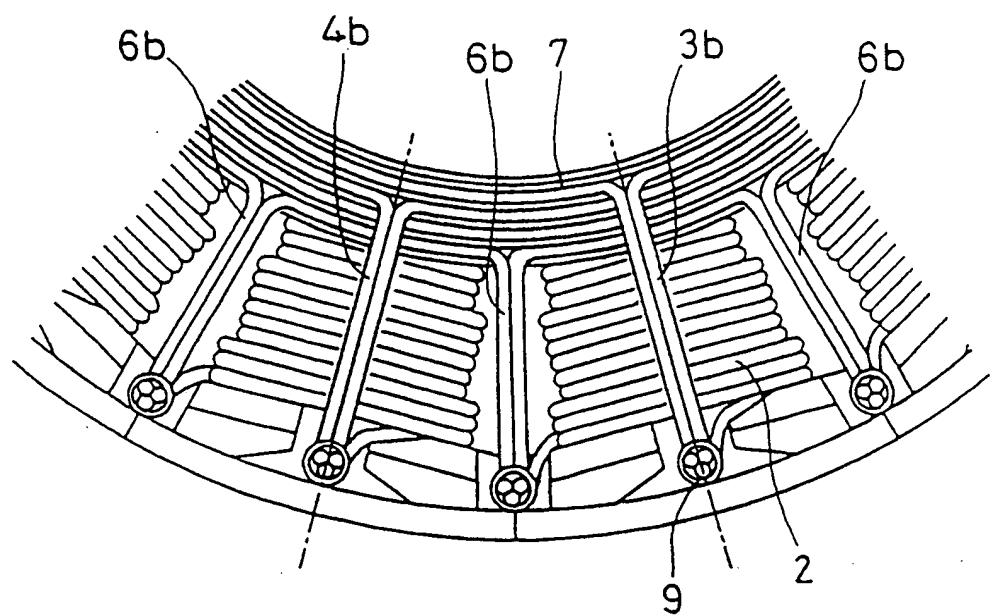


FIG.7





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## EUROPEAN SEARCH REPORT

Application Number

EP 98 10 3639

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.6)						
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim							
A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 167 (E-610), 19 May 1988 & JP 62 277041 A (NIPPON ELECTRIC IND CO LTD), 1 December 1987. * abstract *	1-6	H02K3/52						
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 263 (E-1550), 19 May 1994 & JP 06 038429 A (SHINANO KENSHI KK), 10 February 1994. * abstract *	1-6							
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 210 (E-1537), 14 April 1994 & JP 06 006950 A (MATSUSHITA SEIKO CO LTD), 14 January 1994. * abstract *	1-6							
A	PATENT ABSTRACTS OF JAPAN vol. 010, no. 141 (E-406), 24 May 1986 & JP 61 004430 A (MITSUBISHI DENKI KK), 10 January 1986. * abstract *	1-6	<table border="1"> <tr> <td>TECHNICAL FIELDS SEARCHED (Int.Cl.6)</td> </tr> <tr> <td>H02K</td> </tr> </table>	TECHNICAL FIELDS SEARCHED (Int.Cl.6)	H02K				
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<p>The present search report has been drawn up for all claims</p> <table border="1"> <tr> <td>Place of search</td> <td>Date of completion of the search</td> <td>Examiner</td> </tr> <tr> <td>MUNICH</td> <td>7 July 1998</td> <td>Tangocci, A</td> </tr> </table> <p>CATEGORY OF CITED DOCUMENTS</p> <p>X particularly relevant if taken alone ✓ particularly relevant if combined with another document of the same category A technological background O non-written disclosure P intermediate document</p> <p>T theory or principle underlying the invention E earlier patent document, but published on or after the filing date D document cited in the application L document cited for other reasons &amp; member of the same patent family, corresponding document</p>				Place of search	Date of completion of the search	Examiner	MUNICH	7 July 1998	Tangocci, A
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